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CASE REPORT

# Perioperative challenges and neuromuscular blockade concerns in robotic thymectomy for myasthenia gravis

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**KEYWORDS**
Myasthenia Gravis;
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**Abstract** Myasthenia Gravis (MG) is an autoimmune disease characterized by weakness and fatigability of skeletal muscles, with improvement following rest. It is a disease of great significance to the anesthesiologist because it affects the neuromuscular junction. Robotic thymectomy has come up in recent times due to the minimally invasive nature and its advantages. This presents a new set of challenges for the anesthesia team, and here we present the various anesthesia considerations and perioperative management in a series of 20 patients who underwent robotic thymectomy. As it is a recent upcoming procedure, there is a paucity of literature on this topic, and most of the available literature talks about One-Lung Ventilation (OLV) and thoracic epidurals. To our notice, this is the first literature without the use of OLV and thoracic epidural for the management of robotic thymectomy.


**PALAVRAS-CHAVE**
Miastenia Gravis;
Bloqueio neuromuscular;
Timectomia robótica

## Desafios perioperatórios e pontos de atenção no bloqueio neuromuscular durante timectomia robótica para miastenia gravis

**Resumo** Miastenia Gravis (MG) é uma doença autoimune que se caracteriza por fraqueza e fadiga da musculatura esquelética, com melhora após o repouso. É uma doença de grande interesse para o anestesiologista, pois compromete a junção neuromuscular. Recentemente, a timectomia robótica tem sido empregada por apresentar as vantagens da abordagem minimamente invasiva. O procedimento introduz uma série de novos desafios para a equipe de anestesia. Relatamos aqui as várias considerações anestésicas e o cuidado perioperatório em uma série de 20 pacientes submetidos à timectomia robótica. Sendo um procedimento recente, há limitada literatura discutindo esse tópico e, além disso, a maior parte da literatura disponível

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concentra a atenção na Ventilação Monopulmonar (VMP) e na peridural torácica. A nosso ver, este é a primeiro relato na literatura sem o emprego de VMP e peridural torácica para o manejo da timectomia robótica.


## Introduction

Myasthenia Gravis (MG) is an autoimmune disease which is characterized by fatiguability and weakness of skeletal muscles,[1] with improvement following rest. It might be localized to a specific muscle group or it may be generalized. The etiology of MG is a decrease in the number of postsynaptic acetylcholine receptors at the neuromuscular junction, which causes a decrease in the capacity of the neuromuscular endplate to transmit the nerve signal. Usually the eyelids and extraocular muscles are involved, and bulbar involvement might be manifested as difficulty in chewing and swallowing. Thymoma is usually present in approximately 10-15% of the patients with MG. Thymectomy is a known modality of treatment of MG, and in conjunction with medical therapy, it has shown to increase the probability of remission and overall symptomatic improvement. With the advent of robotic surgery, which is truly minimally invasive, there is another transthoracic option for thymectomy, which can achieve the effectiveness of a transsternal approach without the trauma associated with sternotomy. Robotic thymectomy presents a new set of challenges for the anesthesia team, and here we present the various anesthesia considerations and management in a series of 20 patients who underwent robotic thymectomy. As the disease mainly affects the neuromuscular junction, the major anesthesia challenge was in regulating the intraoperative neuromuscular blockade and the reversal from the blockade at the end of the surgery.

## Cases

We present the perioperative management of successive 20 patients who underwent robotic thymectomy at our institution. The anesthesia protocol followed was similar in all the patients. A thorough preoperative evaluation was done in coordination with the patient's neurologist, and the focus was on bulbar or respiratory symptoms, along with prior history of exacerbations or myasthenic crisis. The dosage of the patient's medications was noted, and pyridostigmine and corticosteroids were continued perioperatively. Pyridostigmine was given on the morning of the surgery and in the immediate postoperative period if required. The anesthesia management consisted of general anesthesia with single lumen endotracheal tube. The difference in our approach with the previous approaches in literature was that, as per our discussion with the surgical team, one-lung ventilation was not needed and so a double lumen tube wasn't required. Carbon dioxide insufflation to a pressure of 10-15 mm of Hg in the capnothorax was used to keep the lung away from the surgical field. The key issue for anesthesia during capnothorax is maintaining stable hemodynamics and oxygenation. Moreover, we used small incremental doses of atracurium titrated to effect and guided using a quantitative train-of-four (TOF) nerve stimulator. Neuromuscular blockade is required for adequate ventilation and maintenance of normocarbia (to prevent the possibility of increased carbon dioxide load due to capnomediastinum) and to avoid any injury to vital structures during surgery due to the movement of patients. Propofol (2-3 $mg.kg^{-1}$) and fentanyl (1.5 $mcg.kg^{-1}$) was used for induction. The neuromuscular blockade was achieved with atracurium (incremental doses of 0.1 $mg.kg^{-1}$), and the airway was secured with an appropriately sized single lumen tube when TOF became 0. TOF was monitored throughout the surgery, and 0.05 $mg.kg^{-1}$ atracurium was repeated when TOF was three or more. For robotic thymectomy, the patient is placed in a side-up position, at a 30° right or left lateral decubitus position. The arm of the elevated side is positioned at the patient's side, as far back as possible, so that there is enough space for the robotic arms. There is an increased risk for brachial plexus injury and special attention must be given to the elevated arm or head to prevent crushing injuries by the robotic arms. Analgesia was provided with paracetamol and diclofenac. At the end of the surgery, neuromuscular blockade was reversed with neostigmine (0.05 $mg.kg^{-1}$) and glycopyrrolate (0.01 $mg.kg^{-1}$), after confirmation of train-of-four (TOF) ratio of >0.9 using a quantitative TOF peripheral nerve stimulator. Postoperative monitoring was done in the postoperative care unit for 1-2 hours, and then the patient was shifted to High Dependency Unit (HDU) for overnight observation and monitoring. We didn't face any major complications (like respiratory arrest or myasthenic crisis) in the postoperative period in any patient, and all the patients were discharged to home on the second postoperative day (Table 1).

In our 20 cases, there were 8 male and 12 female patients with an average age of 35 years. We observed a reduction in the intubating dose of atracurium all these patients, with a mean dose of $6.35 \pm 2.75$ mg atracurium required. The highest intubating dose required was 12 mg for two patients, with the lowest dose being 3 mg. The mean total dose of atracurium used during the surgery was $8.1 \pm 3.09$ mg. We also noticed an increased time period between reversal from muscle relaxant and the last administered dose of atracurium, with a mean time of $69.7 \pm 33.44$ min (range between 30 and 125 min).

**Table 1** Data table: robotic thymectomy.

| Serial No. | Age | Sex M/F | Weight (kg) | Preoperative pyridostigmine (mg) | Previous complications | Total atracurium required for intubation (mg) | Total atracurium required (mg) | Time between last atracurium and reversal (min) |
|---|---|---|---|---|---|---|---|---|
| 1 | 32 | F | 52 | 100 | Ocular | 5 | 5 | 100 |
| 2 | 35 | F | 44 | 300 | Ocular, bulbar | 4 | 4 | 110 |
| 3 | 29 | M | 65 | 300 | Ocular | 12 | 15 | 40 |
| 4 | 42 | F | 41 | 200 | Ocular | 4 | 6 | 45 |
| 5 | 39 | F | 54 | 100 | Bulbar | 5 | 7.5 | 35 |
| 6 | 35 | M | 35 | 30 | Ocular | 3 | 6 | 50 |
| 7 | 37 | M | 61 | 60 | Ocular | 6 | 9 | 40 |
| 8 | 31 | F | 84 | 300 | Ocular, respiratory | 8 | 12 | 65 |
| 9 | 39 | F | 53 | 100 | Bulbar | 10 | 12.5 | 60 |
| 10 | 40 | F | 43 | 30 | Ocular | 4 | 6 | 35 |
| 11 | 28 | M | 49 | 300 | Ocular, bulbar | 5 | 5 | 120 |
| 12 | 45 | F | 55 | 90 | Ocular | 10 | 10 | 105 |
| 13 | 33 | F | 74 | 60 | Ocular | 7 | 7 | 110 |
| 14 | 36 | M | 48 | 120 | Bulbar | 5 | 7.5 | 50 |
| 15 | 31 | M | 39 | 30 | Ocular | 4 | 6 | 45 |
| 16 | 37 | F | 43 | 180 | Respiratory | 8 | 12 | 60 |
| 17 | 35 | M | 61 | 60 | Ocular | 6 | 6 | 115 |
| 18 | 33 | F | 64 | 90 | Ocular | 12 | 12 | 125 |
| 19 | 38 | M | 45 | 30 | Bulbar | 4 | 6 | 54 |
| 20 | 31 | F | 51 | 60 | Ocular | 5 | 7.5 | 30 |

Mean age: $35.3 \pm 4.42$; male: 8; female: 12; mean weight: $53 \pm 12.25$ kg; mean dose of atracurium required at intubation: $6.35 \pm 2.75$ mg; mean total dose of atracurium required: $8.1 \pm 3.09$ mg; mean time between last dose of atracurium and reversal: $69.7 \pm 33.44$ min.

## Discussion

Robotic thymectomy has come up in recent times due to the minimally invasive nature and its advantages,[2] and it also provides a new set of challenges for the anesthesiologist. Along with the neuromuscular blockade and reversal concerns, robotic thymectomy also has other considerations like patient positioning, minimal patient access after docking, capnothorax and resulting high airway pressures, and compression of the heart and major vessels during surgical dissection.[3] A careful preoperative evaluation along with optimization is essential for successful postoperative outcomes. Preoperative anesthetic evaluation of the MG patient includes reviewing of the severity of the disease and the current treatment regimen. Specific attention should be paid to respiratory muscle strength, and the ability to protect and maintain a patent airway postoperatively may be compromised if any bulbar involvement exists preoperatively. Elective surgery should always be performed during a stable phase of the disease, when the patient requires minimal immunomodulatory medication or glucocorticoids to minimize the chance of perioperative myasthenic crisis. Surgery should usually be scheduled as early in the day as possible when the patient is strongest. Patients with MG are treated with one or more of three medical therapies: symptomatic treatment (anticholinesterase agents), chronic immunomodulating treatments (immunosuppressive medication and glucocorticoids), and rapid immunomodulating treatments (intravenous immune globulin and plasmapheresis). We suggest continuing anticholinesterase agents (i.e. pyridostigmine) up to and including the morning of surgery, recognizing that the response to both depolarizing and nondepolarizing NMBAs may be modified by these medications. Patients maintained on anticholinesterases can be sensitive to the discontinuation of the medication, with development of respiratory and bulbar weakness if medication is withheld.

Myasthenic patients, including those with only ocular MG and those in remission, have a variable and unpredictable response to both administration of and reversal from NMBAs as compared with normal patients, including the possibility of cholinergic crisis. They are likely to be resistant to depolarizing NMBAs and very sensitive to nondepolarizing NMBAs. We saw a marked reduction in the intubating dose of atracurium in our patients. In addition, treatment with anticholinesterase medication affects the degree of relaxation and the duration of the action of NMBAs. The mean time between reversal and the last dose of atracurium administered was also on the higher side. Around 40% of our patients did not require a top up dose of atracurium during the whole surgery. If NMBAs are administered, the degree of neuromuscular blockade should always be monitored by using a quantitative train-of-four nerve stimulator. In our cases, neuromuscular blockade with atracurium was provided in all patients, as our surgical team wanted complete muscle relaxation because of the proximity of the surgical site to crucial pericardial structures. We used incremental doses of atracurium along with TOF monitoring for intubation and later during surgery. Muscle relaxation and reversal at the end of surgery were guided by neuromuscular monitoring, and none of the patients showed signs of residual muscle weakness on extubation. The reversal of rocuronium by sugammadex may further enhance the safety of neuromuscular blockade in myasthenia patients,[4] but couldn't be used in our cases due to non-availability of sugammadex in our country.

Anesthesia and perioperative management for robotic thymectomy presents an unique set of challenges for the anesthesiologist. As it is a recent upcoming procedure, there is a paucity of literature on this topic, and most of the available literature talks about management with One-Lung Ventilation (OLV) and thoracic epidurals, without using muscle relaxants. To our knowledge, this is the first literature without the use of OLV and thoracic epidural for the management of robotic thymectomy.

## Conflicts of interest

The authors declare no conflicts of interest.

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